

COSTS AND BENEFITS OF IMPROVING QUALITY MANAGEMENT IN A MULTICRITERIA FRAMEWORK

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Abstract

This paper presents the 2003 results of empirical research carried into effect by using the questionnaire with interview method in one of the leading enterprises of the nutritive sector in Poland. The aim of this exploration was to define an influence of chosen factors, which results from initiating and certifying systems of quality management on the costs and benefits of improvement quality management. Besides, indication which from accepted variants that present adequate quality systems, best satisfy all analyzed factors, simultaneously supplies the biggest benefits to enterprise. To solve this problem, the Analytic Hierarchy Process (AHP) method with cost – benefit analysis was applied allowing for complex formulation of a given problem. The author's intention was to show the utility of these methods in the solution of this problem and in similar multicriteria decision problems.

1. INTRODUCTION

In the last decade the meaning of the function of quality has grown significantly. It is considered that the 21st century will be the era in which management will be undertaken under its primacy. Quality is not only the most important weapon in international trade; it is the best defense against environmental threats (Janicki, 2001). However, quality is not an ideal state, but an objective subject to change and evolution that must always be pursued. Consequently, we often define it as “a port of destination”. Achieving this aim is a difficult task, because it is accompanied by uncertainty and risk. Moreover, we need also to deal with lack of reliable information, disbelief and fear of the unknown (Skrzypek, 2002).

2. QUALITY AS A COMPETITIVE ELEMENT IN THE ECONOMY MARKET

Poland's recent integration with the European Union (EU) and its status as the biggest importer and exporter of food products in the world will attract more attention towards competitive problems. While Marczak (2002) supports this notion, he argues that it is simply a matter of economic ability (or any their element) to derive profit over costs from economic activity. However, since the effectiveness of competitive policy instruments is dependent not only on the government, but also on producers, manufacturing enterprises will be required to introduce considerable changes. This is particularly true for those who want to enhance their competitive position and sustain their survival at a time when customers have access to products in the global market. This access creates more demanding, customers, driving manufacturing enterprises to place attention on factors other than price to remain competitive. Literature of subject often serves that Poland rivalry in condition of union custom will be relying on qualitative competition. Thus, it appears necessary that Polish firms adapt methods for improving the quality of products; methods which are not only proven effective in developed countries, but also applicable in our condition. Technical acceptance indicating quality of final product is no longer adequate. Nowadays, food product suppliers must also prove that they implement quality system that assures consistent delivery of product that is safe with respect to health and meet high quality standard (Gręda, 2002).

It is noted that Polish enterprises have started to initiate quality systems since early 1990's. Poland is relatively inexperienced in quality practices compared with implementation in other countries of Western Europe, not to mention USA and Japan. For this reason, there has been a growing interest in quality problems among theorists and practitioners of this domain during the last few years. It is shown by the rich literature of the subject and the existence of numerous congresses and scientific conferences, devoted to address this problem in Poland and abroad. Moreover, in the last decade the number of enterprises that are certified for their conformity on elaborated quality systems has increased considerably.

According to the latest data, the number of certificates awarded in Poland amounts to over 6.000 and it represents 1% of the number issued in the world (Lisiecka, 2003). The certificate presents a recognizable symbol of quality, affecting client consciousness and facilitating a distinction of quality in the product, service, and firm. The affirmation of "*we possess quality symbol*" or "*quality certificate*" evokes a positive reaction in recipients, because it means that the organization assures owned features, guaranteeing "what is good". The word *quality* has a positive association, enabling the quality certificate to be perceived as a guarantee that a firm's money is properly spent (Adamus & Matuszyńska, 2002). Currently, about 52% of the firms in Europe are certified, the public often considering such firms' products as worthy to buy. Firms without either quality certificates or symbols on their products will struggle with more problems in their market. Such products are often left unpurchased by clients with a choice (Adamus & Gręda, 2002a).

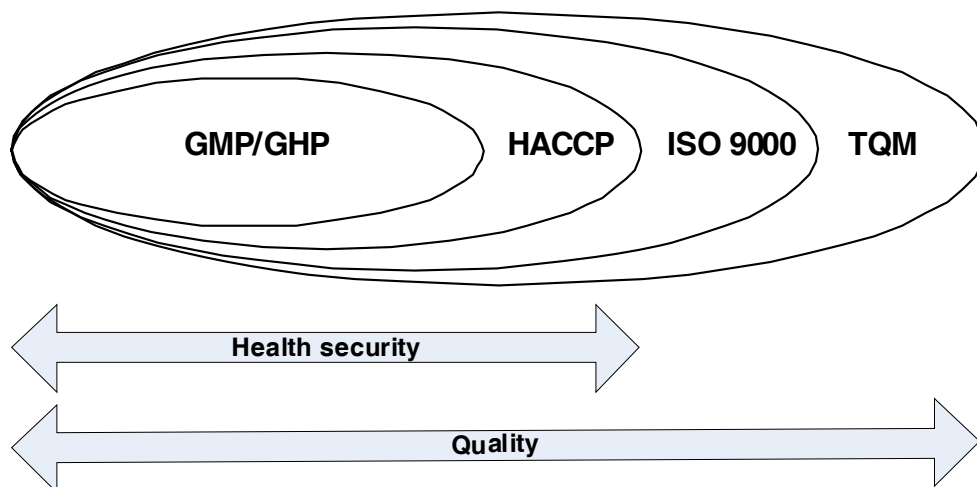


Figure 13.1: Relations Between Safety and Quality Management Systems

Source: Based on Sikora & Kotożyn-Krakowska (2001)

Enterprises that make decisions to initiate quality management have many alternatives as to which systems to adopt. These systems differ in aspects such as operational implications, requirements, and the principles to follow in their implementation. The most popular approaches for the food industry include: GMP – *Good Manufacture Practice*, GHP – *Good Hygienic Practice*, HACCP – *Hazard Analysis and Critical Control Point*, norms ISO 9000 series, and TQM – *Total Quality Management*. These systems complement each other as presented in **Figure 13.1**. Successful implementation of the systems minimizes the possibility that purchasers will buy defective products and maximizes the possibility that purchasers will buy reliable products with respect to health and utility. Quality systems take the whole chain of producing “from farm to fork” into consideration (Adamus & Gręda, 2003).

Implementing these systems would require the reorganization of work and enhancement of employee competence in manufacturing, thereby decreasing the number of defects. All of this leads to cost reduction and organizational effectiveness. The process involves optimal integration of the different systems, requiring a *continuous quality improvement* approach. In the end it is the customer who would be the ultimate verifier of how the system implementation contributes to satisfaction, opening the door for economic growth.

3. QUALITY COSTS AS AN INDICATOR OF FIRM EFFICIENCY

Quality is a relative notion and may have different meanings for different people, depending upon the context in which it has been used. Thus, it is very important to

represent quality from both the producer's and consumer's points of view. From the producer's side, the most important definitions of quality relate to becoming profitable and competitive in the market. An aspiration to achieve an increment from economic activity, especially of quality improvement, requires explorations and development expenses, projects and prototypes elaborations, conducting a semi-technical scale of production and marketing. Obtaining a required quality of product is related to the proper costing of manufacturing, service and subsidiary services. The quality of a product presented in cost categories gives an image of a wide spectrum of operations. The operations include the design, production, and offering of the product. When analyzing the notion of quality with respect to costs, it is difficult to discuss the minimalization of all the product's costs, except the costs of bad quality. Hence it is better to examine the strive to optimize costs.

The range of the quality concept from the producer's point of view, binds with the firm's competitiveness and its products in a given sector and in the whole market. For the competitive elements, we can include for example, image, leadership, and continuous organization improvement. From the consumer's point of view this means satisfying needs, both functional and nonfunctional. Functional needs are related to the exploitation of a product and its disposition; for example features like comfort of using the product or the implementation of utilitarian function, reliability, reparation, and guarantee. Nonfunctional needs are related to the aesthetic impressions, likeness, and product image (Borucki & Urbaniak, 1996).

Quality competitiveness makes sense then, even if it is possible to approximate the costs. It has much importance, because deliver information, e.g. the scale of realization and the effectiveness of actions connected with functioning systems of quality management. Besides, it helps to identify and understand problems as areas with high quality costs. An optimization of these costs presents a source of measurable benefits, because of the possibility of quality improvement, profitability and competitive growth. Skrzypek (2000) supports this opinion and confirms that it is possible to manage only with this: what one can measure and define. However, quality estimation performed by its prism of costs is a difficult process. Its results in enterprise exist in many areas, where operations connect with quality, relying on themselves, and repeatedly coherent with the process of producing. Dahlggaard (2000) made a note and said that problems rely on it, that these costs are mostly invisible. So, a risk occurs of serious threat i.e. "managing only by using visible number without taking into consideration those which are unknown or unrecognizable". Crosby's (1982) point of view is also very important. According to his opinion we count only $\frac{1}{6}$ of the costs of quality and $\frac{5}{6}$ of them escape. It is crucial to find the majority of these costs, to identify and manage them profitably.

Resumption of better operational effectiveness becomes a necessity of each organization in variability found in today's environment. Consequently, enterprises should look for methods to reduce costs, liquidate sources of waste and try to extend their efficiency. One way to realize cost reduction is the investment in quality, which becomes an essential phenomenon of the contemporary world. Pawlak's (2001) opinion of traditional enterprises is that they do not have systems of quality management. Distributions of costs are as follows: costs of internal and external defects – 65 to 70%,

costs of researches and estimates – 20 to 25% and costs of preventions of faults – 5 to 10%. The high costs of products defects are offset by the minimal expenses required to prevent them. These operations, although marginal, are cheaper and more efficient in such kind of firms. A system of quality management implements in effect, a way that firms can considerably reduce costs of quality. For that reason, we should not omit these costs in strategic and operative decisions making, because they have an influence on financial balance of enterprise. When talking about costs of quality, individuals often say that “quality is free” (Crosby, 1982) or “cost of low quality is extremely high” (Dahlgaard, 2000). This aspect Steinbeck (1998) explains that continuous quality growth costs nothing, because benefits cover costs, and bring forth-net profit. He indicates also that improvements gained in such a way usually amount to more than 50% and the reduction of defects is from 10 to 100 times. However, it needs to be noted that in order to estimate these costs, enterprises should utilize proper methods, which allow them to make such measurement.

4. PURPOSE OF EXPLORATIONS

The purpose of this work was to define an influence of chosen factors, which result from initiating and certifying systems of quality management on costs and benefits of improving quality management. Moreover to choose an operational strategy that will enable the best solution of a given problem. Such research has not been realized up to now. Conducting this research will allow managers to take proper action, which can decrease costs and increase the advantage of possessing systems of quality management. To be able to do it, one should use quantitative methods of quality estimation. This is essential, because it is not possible to observe and measure something that does not have specific criteria attached to it. Without quantifiable criteria, we can not represent quality with numbers. Criteria allow us to estimate an efficiency of personal action and if need be, to take appropriate preventive work. It is important to note that many economic methods exist, but the old ways of quantifying quality are no longer sufficient. It results from a part approach to this problem, which did not always let to attain a forceful solution. Requirements exist today for such methods, which allow formulating a complex model of a given problem. Only then will it be possible to realize actions, which are close to optimal, and at the same time achieve the most appropriate decisions. In this work, the author makes an attempt to apply a new multicriteria mathematical method – the Analytic Hierarchy Process and cost – benefit analysis, to make a solution of a given problem. The author’s intention is to present the utility of these methods in this question and in similar multicriteria decision problems.

5. GENERAL PRESENTATION OF EXPLORED ENTERPRISE¹

Explorations were taken in one of the leading enterprise of food sector in Poland, which engages in the production of fruit – vegetable preserves and juices. This firm, with 80 years tradition in production, possesses a large trademark huge approval among consumers in the domestic market and abroad. It proves this by receiving medals, distinctions and the leading places in various contests. This firm also participates in many charitable actions. It uses modern production technology, cooperates with the best research centers in the world, and has a strong staff of skilled specialists. This industry was chosen for this particular research because it possesses certified quality systems, used to define model examples of quality management. This enterprise possesses systems of *Good Manufacture Practice* (GMP), *Good Hygienic Practice* (GHP), *Hazard Analysis and Critical Control Point* (HACCP) and *norm ISO 9001 series*. HACCP system exists in enterprise since 1997, but ISO 9001 since 1999. Firm was certified by *British Standards Institution* (BSI) and *Polish Centre of Research and Certification* (PCBC).

During this research, the firm was in possession of partially integrated systems, mainly through documentation. It has also started to project their transformation by having the strictest integration of the HACCP system with norm ISO 9001. To solve this problem three procedures were elaborated. These systems were joined through the oversight of water and sewers, wastes and litters, and the risk analysis of products and processes.

6. CHARACTERISTIC OF EXPLORATION METHODS

This article presents an attempt to express, in a systemic way, the form of one multicriteria mathematical model with the factors that influence the choice of the best strategy of quality improvement. The AHP method and cost-benefit analysis have been used for this purpose.

The cost-benefit analysis appears to be useful in estimating qualitative undertaking in food economy. It represents a tool, which simplifies the process for managers, who make future decisions about initiating systems of quality management in the agric – food sector. This tool will help to choose the best course of action. Before making investments in costs of quality improvement, which include training, planning and production development, it makes sense to answer the question: “do the benefits from solving the problem justify the cost?” If so, then the benefits are more important than the costs and making a decision is based on the benefits. But, if both costs and benefits are comparably important, then the problem needs to consider both categories. When benefits do not justify costs, the costs imply the choice for the best alternative is the one with the lowest costs. Moreover, risk is what presents large importance in undertaking tasks. When the risk is equal for both costs and benefits then it can be omitted from the decision process.

¹ By the reason of lack of agreement of using the firm's name, author does not provide it in the content of article.

The reason for applying this method is for economic effectiveness, by which we understand the best case of utilizing an enterprise's stocks (Adamus & Gręda, 2002b).

In this article, the author tries to present different variants of strategies using the cost-benefit analysis frame, which will allow for achieving the best quality of product. In order to attain this, one of the multicriteria methods was used – the Analytic Hierarchy Process. The simplicity of this method allows for it to be used by managers in rationalizing management and the organization of enterprise. At the same time, it contributes to quality improvement.

The AHP is a general theory of measurement connecting some concepts from mathematics and the psychology domain. A hierarchic decision scheme is constructed here, by the breaking the problem into decision elements: goal, criteria, subcriteria and decision alternatives. The goal is on the top of hierarchy, whereas alternatives create the lowest level of hierarchy. The importance of every decision element is established, through the pair-wise comparison of elements on each level of the hierarchic structure, with regard to elements on the level above (Saaty, 2001). On the basis of these comparisons, we construct an additive model in a quotient scale, which describes the preferences of the decision maker. This model is called a priority function. The alternative of the decision, with the highest value of priority function, is considered to be the best and recommended for realizing in practice (Adamus & Gręda, 2002c).

The main research was carried out personally in 2003, with the aid of questionnaire and interviews with chosen employees of the enterprise that fulfills the functions on different grades of managing. The questionnaire with interview was divided into two parts, representing two problem groups. The first characterizes costs and the second characterizes benefits resulting from initiating systems of quality management in the food industry. They have been used to structure AHP hierarchy in the range of costs and benefits. The goal on the top of the hierarchy was to improve the quality of products, grow economic results and improve enterprise development. Both parts of the questionnaire took into consideration four general criteria in an enterprise's activity: organizational, productive, technological and economic. It was possible to define subcriteria that affect the benefits and costs of a firm's quality improvement. By the using of the AHP method, respondents made comparisons of elements in pairs. During the making of comparisons, respondents answered the following questions: which of these two criteria (subcriteria) that they compare in pairs is more important (more preferred) in realizing the goal. In order to do this, respondents were to mark the dominance of one criterion (or subcriterion) over another by using Saaty's fundamental scale from equal (1) to absolute (9).

Chosen employees pair-wise compared all criteria, subcriteria and decision alternatives included in the hierarchic structures of costs and benefits. On the basis of these comparisons, using of Analytic Hierarchy Process, the priorities for each criterion, subcriterion and decision variant were calculated. This enabled us to show the most costly and beneficial elements resulting from initiating quality systems in the enterprise. The use of the AHP method with cost – benefit analysis indicates which decision variants best satisfy all analyzed factors and at the same time supply the biggest benefits for enterprise.

7. RESEARCH RESULTS

Effectiveness of a pro-quality firm's operations, and its marketplace success, in large part depends upon one of the most important management functions in the enterprise: decision making. Decision-making is mostly within the managers' domain, but also concerns all employees in firm, through the fulfillment of their functions. In daily life of all of us are required to make hundreds of different decisions and execute the different choices. In order to make appropriate decisions, which help us to find an optimal solution of an existing problem, we have to make use of a complex approach to specify a question and perform a deep analysis.

It is important to note that a specific decision making problem exists because one is obligated to weigh two alternatives at least, and choose this kind of them that will best contribute to satisfying the goal. It is not possible to make a proper decision and arrive at an effective solution of a problem if we use only our intuition. More and more people want to eliminate errors in making decisions and so use procedures, techniques, rules and models of decision processes to arrive at improvements.

This article presents the capability of utilizing in Polish conditions one of the faster developing in last years method, used for solving multicriteria decision problems. It presents the Analytic Hierarchy Process (AHP). This method with the cost – benefit analysis is used to choose the best strategy for product quality improvement, economic growth and enterprise development and to characterizing the influence of selected factors on the costs and benefits of these operations.

Figure 13.2 presents the AHP costs' hierarchy. General criteria on the second level include: organizational, productive, technological and economic. The third level of the hierarchy presents subcriteria, or elements, that affect the costs of quality in firm.

By making comparisons, respondents identified the largest cost as the economic costs of quality improvement. They were mainly used to obtain important information about market requirements and client demands with respect to products. This factor received the highest value amount 0.1742. Next were productive costs.

During the construction of the hierarchic structure on the fourth level, three strategies of quality improvement were elaborated. Variant A presents a system of assuring the quality of food and food's safety. It presents a connection of Systems: Good Manufacture Practice/Good Hygienic Practice (GMP/GHP) and system HACCP (Hazard Analysis and Critical Control Point). The most important principle of this system is the prevention, identification and elimination all potential threats against a product's quality in the whole food chain "from farm to fork". This is an important notion relative to consumer's safety and health protection. Variant B presents System of Quality Management as norms ISO 9000 series. It gives attention mainly to economic and the organizational effects on the enterprise. It is possible to connect a firm's departments and employees in quality action. Variant C accepts the Integrated Systems of GMP/GHP, HACCP and ISO 9000. This connection was performed to be able to confirm or deny many researchers' opinion (especially for food enterprises) surrounding the joint initiation of quality systems or maximization of their integration. Such operations have beneficial influence on the quality of products and quality management in firm. It assures their proper functioning in food production and selling.

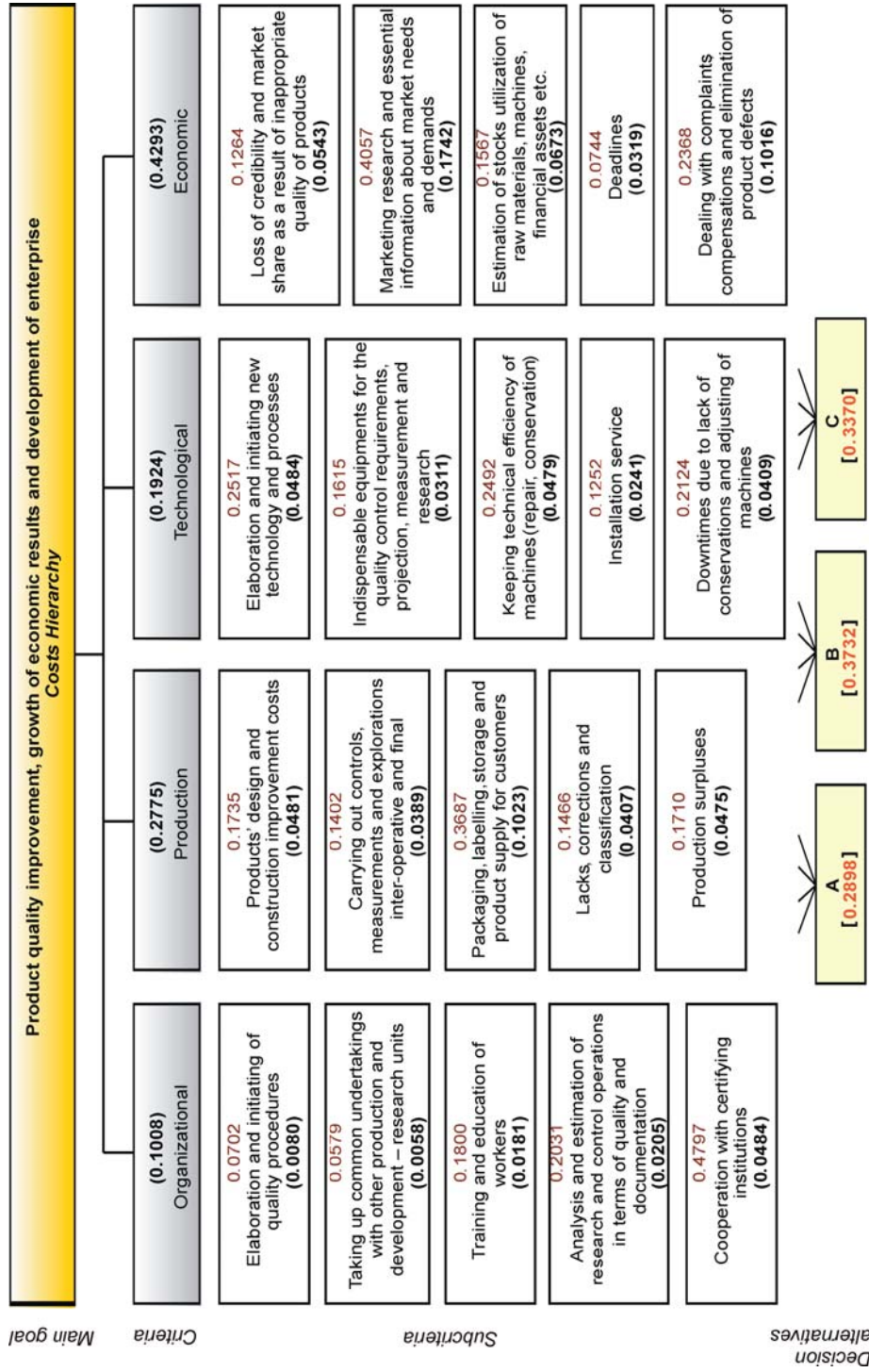


Figure 13.2: Costs Hierarchy of Products Quality Improvement, Growth of Economic Results and Enterprise Development

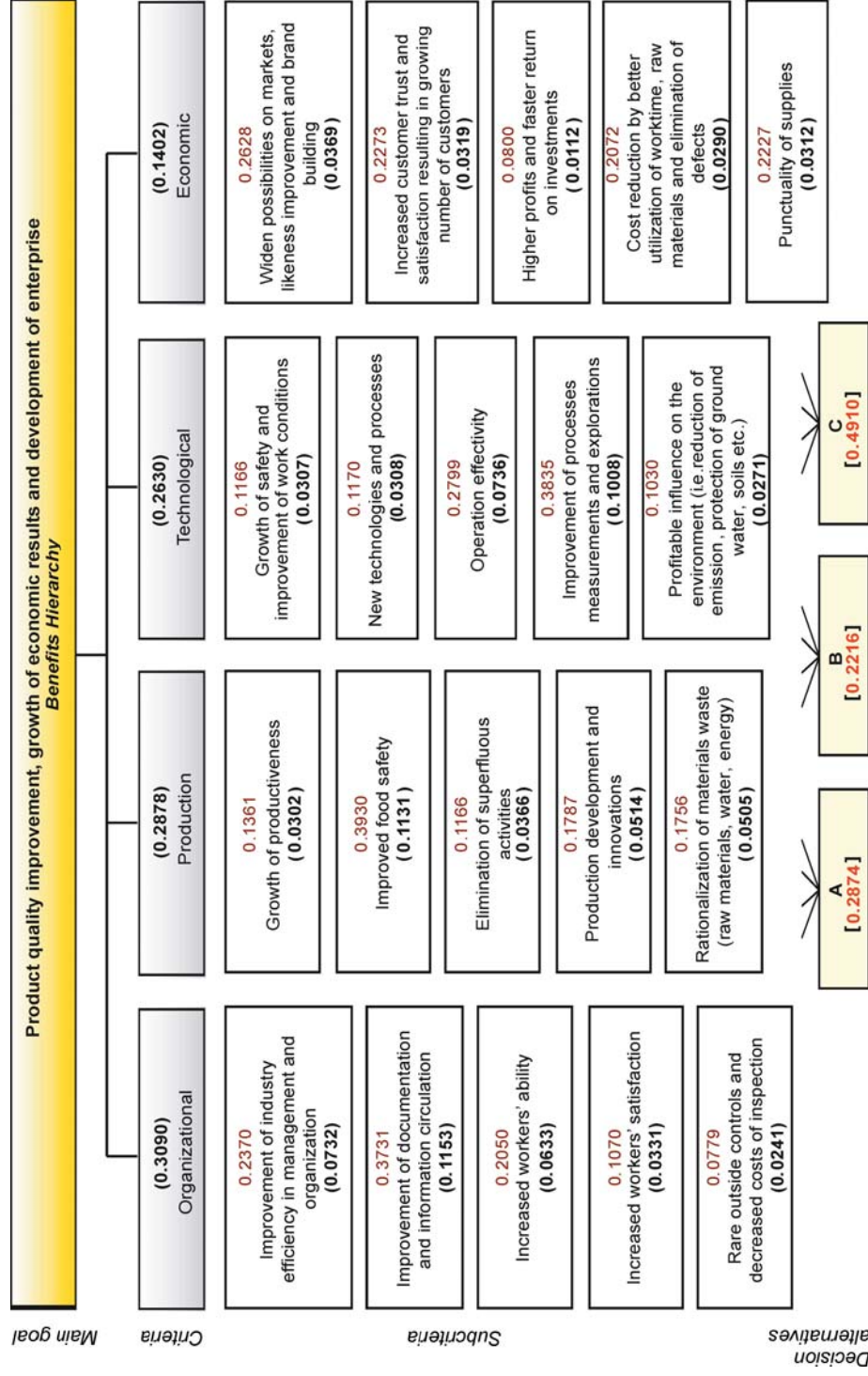


Figure 13.3: Benefits Hierarchy of Products Quality Improvement, Growth of Economic Results and Enterprise Development

Figure 13.3 presents the AHP benefits hierarchy arising from product quality improvement, growth of economic results and development of enterprise. On the second level of this structure, general criteria were created analogous to the costs hierarchy. The fourth level presents in the same way as in the costs hierarchy, decision Variants A, B and C. Comparisons and calculations were done in a similar way as were done in the costs hierarchy. From the respondents' opinion, it resulted that the largest benefits from initiating and certifying systems of quality improvement are observable in an organization. Those are mainly throughout the improvement of documentation and information circulation. Next, benefits were observed in production, first of all in the range of improvement of food safety.

Numbers as presented in **Figures 13.2** and **13.3**, show priorities of elements in the realization of the main goal. Priorities in parentheses on these illustrations result from multiplying priorities on levels II and III. For example value 0.1131, shown in parenthesis on the **Figure 13.3** for increasing food safety, results from multiplying 0.3990 (priority for increasing food safety results from matrix comparisons of elements on the level III with respect to element on the level II – productive) by priority for productive 0.2878. Priorities shown in parentheses are equal to the prioritization of elements in relation to the ones on which comparisons were made (0.2878).

The sum of all priorities on each level equals unity. It is important to note that priorities for all variants present on the fourth level in the hierarchy of costs (**Figure 13.2**), benefits (**Figure 13.3**) and in the **Table 13.1**, were calculated by pair-wise comparisons with respect to every subcriterion, first in costs hierarchy and then in the benefits hierarchy.

The outcomes show that the largest benefits to the enterprise will be Variant C of quality improvement. In relation to cost, the main priority is Variant B, which is a system of quality management such as norms found in the ISO 9000 series. In optimal decision making concerning improvement of quality products, growth of economic results and enterprise development are very helpful in calculating the relation of benefits to cost. This results from the principle of benefits to cost proportion, which says that *we should realize given enterprise or program at that time, when all – out benefits exceed all – out costs*. Priorities for the three variants were computed in the way presented above and listed in **Table 13.1**.

Table 13.1: Overall Outcome of Application AHP Method with Cost-Benefit Analysis

Decision variants	“Benefits hierarchy”	“Costs hierarchy”	Rate “benefits to costs”
A	0.2874	0.2898	0.9917
B	0.2216	0.3732	0.5938
C	0.4910	0.3370	1.4570

Research estimation shows that the best strategy in realizing the goal seems to be variant C, which is Integrated Systems of Quality Management presented in connection with Good Manufacture Practice/Good Hygienic Practice Systems (GMP/GHP), HACCP system and norms ISO 9000 series. Therefore operational leads in the analyzed firm, which purposely have the greatest integration of these systems, should bring benefits for the given enterprise.

On this basis, we can affirm that the decision seems to be reasonable in light of researchers' recommendations regarding joint initiation of these systems or maximization of their integrations. Such operations lead to reduced costs, related to independent functioning of these systems. This mainly results from the elimination of duties and documentation, which can be repeated when these systems are treated separately. It is worth noting that some "signpost", or help, is available in norm ISO 15161:2001 for firms that intend to jointly initiate these systems or do their integration.

It includes directions for application of ISO 9001:2000 norm with HACCP system in the food industry. They have been elaborated by the Technical Committee ISO TC/34 "Agricultural and food products" (ISO 15161:2000).

8. CONCLUSIONS

Studying this problem leads to deep thoughts on how important quality is in each person's life. It functions in many grades of human activities, including quality of product, services, work and life. For this reason, my attention was concentrated on the food industry, because food directly impacts our existence. Quality has such influence on generations' health and life now and in future.

Success in the market of each organization, in large measure, is dependent upon proper decision making. Hence in this work the author tries to present the utility of the multicriteria method of decision making – Analytic Hierarchy Process and cost-benefit analysis. Together, these methods can be successfully applied to solving almost every multicriteria undertaking, particularly in the food industry.

Research realization allows extraction of the following conclusions:

- The connection of AHP and cost – benefit analysis allows for formulation of problems of quality management in the form of one multicriteria mathematical model;
- In an effort to choose the best variant of improvement of quality management in researched enterprise, three alternatives are accepted which, during the comparisons, refer to all factors in costs and benefits hierarchy;
- The relation of benefits to costs priorities of variants has identified a variant which, if initiated, should bring relatively big benefits for the researched enterprise;
- The presentation of the connection of the AHP and cost – benefit analysis turns out to be very useful and helpful when making difficult decisions about quality and supplying essential information to enable rational management in the enterprise.

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